Space Weather Technical Forecast

Issued on Saturday, 08 January 2022 at 00:25 Local

This technical forecast provides a four day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales

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Space Weather Forecast Headline: Slight chance of G1/Minor Storm Days 1 and 2 (08 and 09 Jan), and M-class flares (R1-R2 radio blackout) throughout. Chance of Active fluence by Day 4 (11 Jan)

Analysis of Space Weather Activity over past 24 hours
Solar Activity: Solar activity was Low over the past 24 hours, with two C-flares observed, from AR2924. There are currently two sunspot regions on the visible disc; AR2924 Eai/Beta-Gamma and AR2925 Cai/Beta, both located in the southeast quadrant. No Earth-directed CMEs have been observed from currently available imagery.

Solar Wind / Geomagnetic Activity: Solar winds, as observed by DSCOVR at L1, were largely stable at ambient levels through this period. Wind speeds showed a slight decrease, and are now near or just above 300 km/s. Density has been largely below average. The interplanetary magnetic field strength (IMF Bt) was weak at 4 nT or below. The Bz varied between +4/-2 nT, but was largely positive. The Phi angle has been predominantly positive (away from the Sun). Geomagnetic activity has been Quiet (Kp 0).

Energetic Particles / Solar Radiation: The high energy proton flux (greater than 10 MeV) remained at background levels. High energy electron flux (greater than 2MeV) was at mostly moderate levels, peaking at 822 pfu at 07/1510 UTC. Electron fluence remained below the Active threshold (1e8 integrated pfu) on a steady trend, with 3.97e7 integrated pfu recorded at 08/0000 UTC.

Four-Day Space Weather Forecast Summary
Solar Activity: Solar activity is expected to remain low or very low with further C-class flares possible and a slight chance of M-class flares, most likely from AR2924. Returning previous regions are expected to rotate onto the visible disc during Day 1 (08 Jan). Solar activity is likely to increase as these regions rotate on, giving a gradual slight upward trend in flare risk.

Solar Wind / Geomagnetic Activity: There are currently no Earth-directed CMEs. Solar wind speeds are starting at ambient levels, before a CIR and high speed stream from CH43/- is expected to arrive later on Day 1 (08 Jan). Wind speeds may reach elevated levels, before slowly declining later in the period. Quiet geomagnetic activity is expected at first, increasing to Unsettled to Active with a slight chance of G1/Minor Storms later on Day 1 into Day 2 (09 Jan). Activity is currently expected to return back to Quiet again during Day 3 (10 Jan).

Energetic Particles / Solar Radiation: High energy (greater than 10 MeV) proton flux is most likely to remain at background levels. However, there is a very slightly increasing risk of a proton event as AR2924 moves towards the western side of the Sun. The High energy electron flux (greater than 2MeV) may reach the High (1e3pfu) threshold on Day 1 (08 Jan), but is then likely to be suppressed by the arrival of the HSS from CH43. An increase is then possible later in the period as the HSS subsides. The electron fluence is likely to decrease late Day 1 into Day 2, before an increase may occur from Day 3 onwards, with a chance of reaching the Active threshold.

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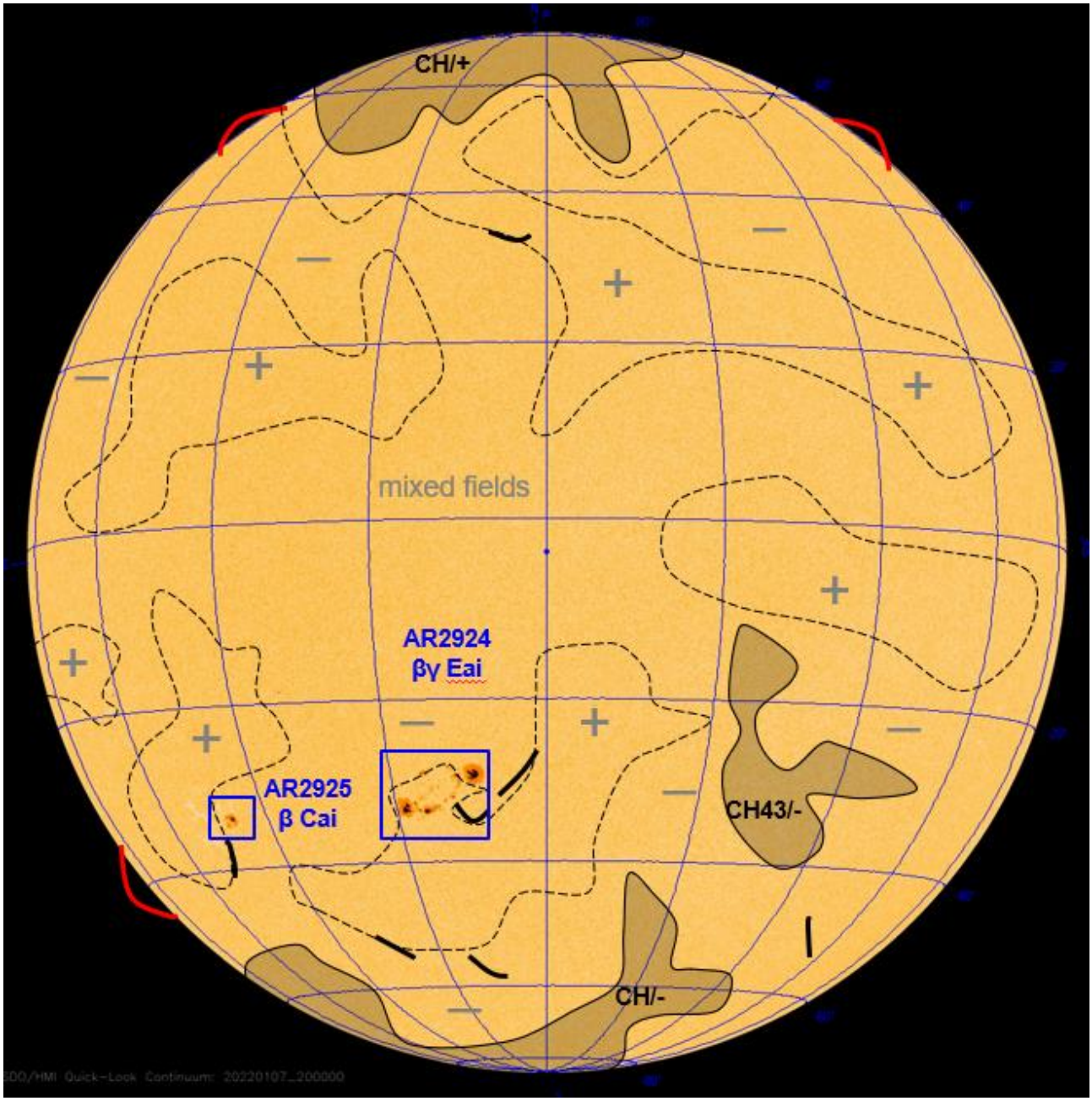
Figure 1. Solar Analysis Valid 07/2000 UTC.



Key: Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

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Geomagnetic Storms:

There are currently no Earth-directed CMEs expected.
Solar wind speeds are currently ambient, however a CIR and high speed stream from CH43/- is expected to arrive later on Day 1 (08 Jan). This is a new feature on this rotation, therefore confidence is moderate on timing and strength. The most likely wind speeds are elevated at around 500km/s. STEREO-A saw this feature at a time that would indicate late Day 1 for arrival at Earth. Wind speeds at STEREO were around 400-450 km/s, but the spacecraft is further away from the coronal hole than Earth so a stronger connection is likely here.

Quiet geomagnetic activity is expected at first, increasing to Unsettled to Active with a slight chance of G1/Minor Storms for a 24 to 36 hour period after we connect to CH43. Activity is currently expected to return back to Quiet again during Day 3 (10 Jan).

Geo-Magnetic Storm Probability (Exceedance)	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Minor or Moderate	G1 to G2	No	20	20	5	1
Strong	G3	No	1	1	1	1
Severe	G4	No	1	1	1	1
Extreme	G5	No	1	1	1	1

Geomagnetic Activity - Earthbound Coronal Mass Ejections

Date/time 21.5R (UTC)	Halo: Full or Partial	Source	Source Location	Estimated Speed	Estimated Arrival Time	Comments
*	*	*	*	*	*	*

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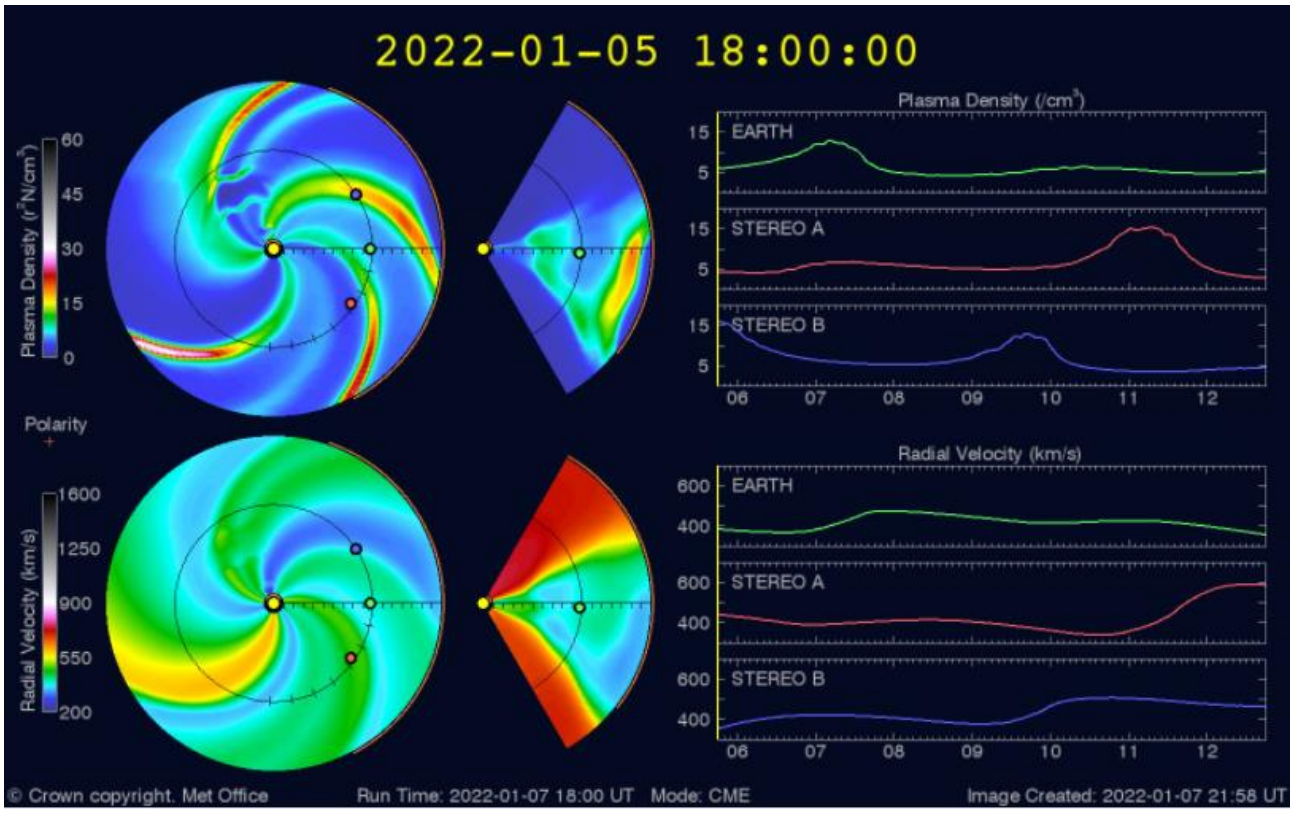
Figure 2: Enlil model. It is showing the arrival of the HSS from CH43 slightly too early, with the most likely arrival time later on 08 Jan. Peak wind speeds may be slightly higher than suggested by Enlil, perhaps reaching around 500 km/s.



Radio Blackouts - X-Ray Flares:

Solar Activity is currently Low. There are two sunspot regions on the visible disc; AR2924 (Eai/Beta-Gamma) and AR2925 (Cai/Beta), both in the southeast quadrant. AR2924 has continued to grow with further intermediate spots developing, and a gradual increase in magnetic flux. AR2925 appears stable. Two or three likely active regions (possible returning regions from the previous rotation) are expected to rotate onto the visible disc during Day 1 (08 Jan). The area in the south corresponds to the regions of ex-2907 and ex-2908 on the previous rotation, and the one in the north is possibly ex-2911, all of which produced M-flares on their previous transit across the Sun.

Low or Very Low solar activity is expected to persist, but may increase with the arrival of these returning regions, bringing an increasing chance of isolated M-class flares.

X Ray Flares	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability			(%)	(%)	(%)	(%)
Active	R1-R2 M Class	No	10	15	20	20
Very Active	R3 to R5 X Class	No	1	1	2	2

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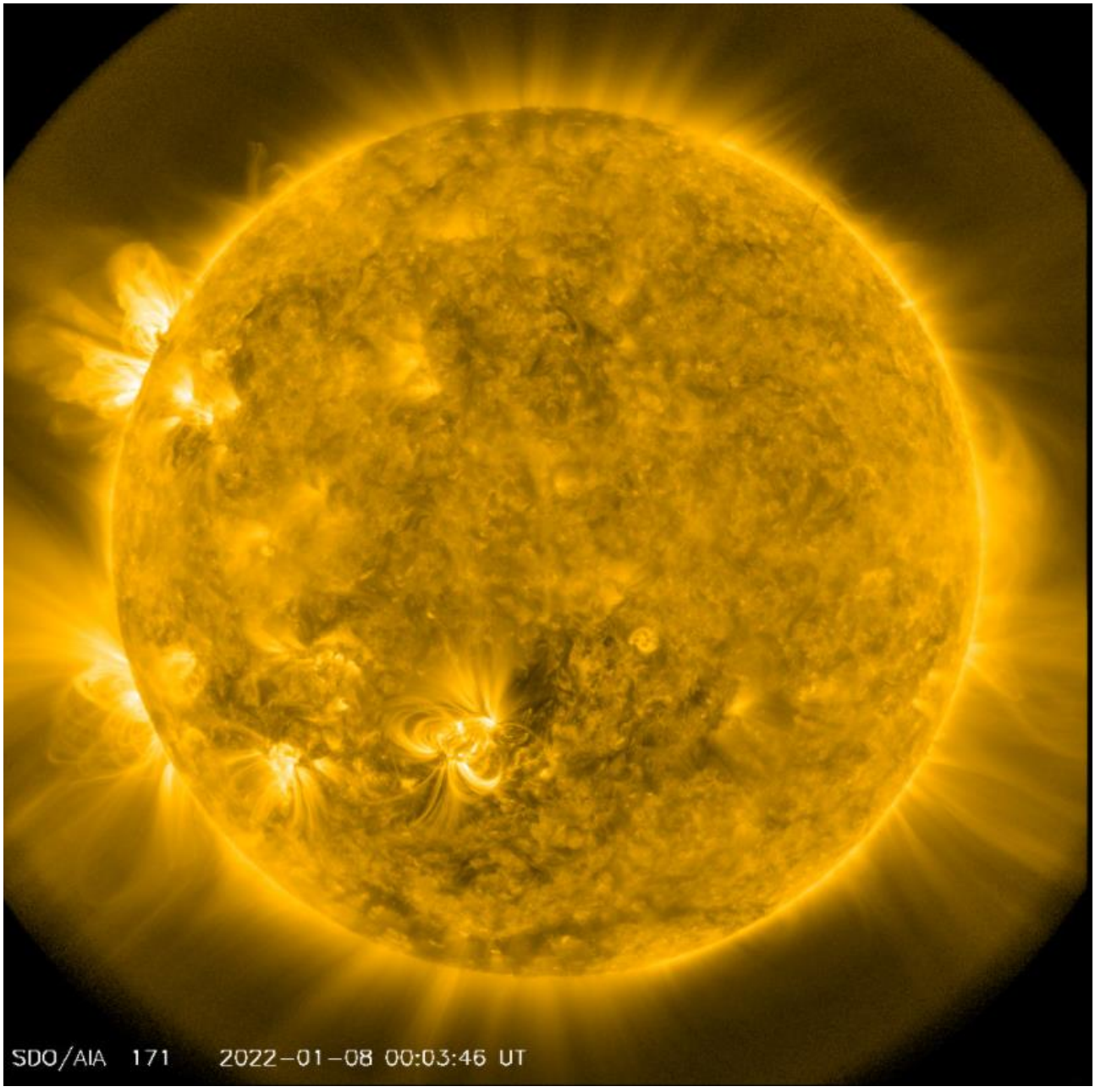
Figure 3: AIA-173 imagery showing magnetic looping of approaching active regions, near both the northeast and southeast limb.



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Solar Radiation Storms - (High Energy Protons):

The high energy proton flux (greater than 10 MeV) as observed by GOES-16 is currently at background levels and will most likely persist at this level in the absence of solar activity. There is just a very slightly increasing chance of a slight rise in proton levels as AR2924 rotates towards the western side of the disc.

Radiation Storms Probability (Exceedance)	Level (cm^{-2} sr^{-1} s^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ S1**	No	1	1	2	2
Very Active	**≥ S3 ***	No	1	1	1	1
* S3 ≥ 10 MeV ≥ 1000 pfu and / or ≥ 50 MeV ≥ 10 pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$)						

High Energy Electrons Event (≥ 2MeV):

The high energy electron flux (greater than 2MeV) as observed by GOES-16 is currently at moderate levels, but diurnal peak values may be close to, or temporarily just exceed, the High threshold on Day 1 (08 Jan). The expected arrival of a high speed stream from CH43/- later on Day 1 is likely to suppress flux levels as the radiation belts are compressed. An increase is then possible from Day 3 (10 Jan) if any charging has occurred as the belts de-compress.

The electron fluence is most likely to remain below the Active level (1e8 integrated pfu). A decrease is expected late Day 1 into Day 2, before an increase may occur from Day 3 onwards, with a chance of reaching the Active threshold. REFM is showing a general decreasing trend, but this is due to the fact CH43 was not present on the last rotation. As such, REFM is not currently giving good guidance beyond the end of Day 2.

GEO Electron Environment Probability (Exceedance)	Level (cm^{-2} sr^{-1} day^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ 2 MeV ≥ $1x10^8$**	No	10	5	20	30
Very Active	**≥ 2 MeV ≥ $1x10^9$**	No	1	1	1	1

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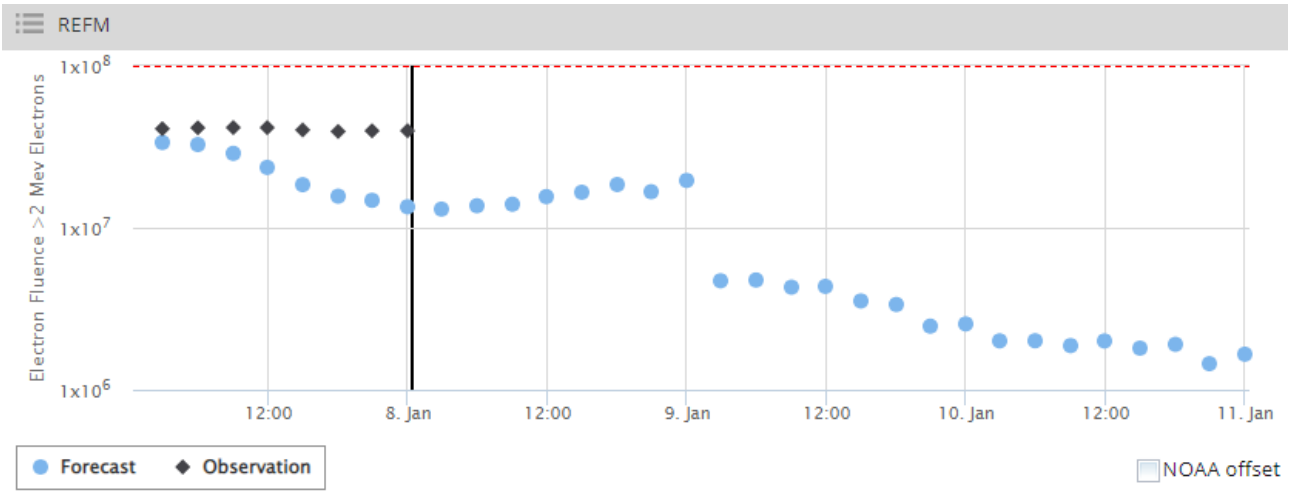
Figure 4: REFM model showing a steadily declining trend. This is unlikely to be correct after Day 2, as CH43 wasn't present on the previous rotation and as such REFM won't be taking the likely arrival of the associated HSS into account for the forecast.



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